NuMI Beam Simulation -- the reunification

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Revisiting the plan for a unified ntuple

- Proposal: MINOS-DocDB-9070 (via https using cert)
  - initial version publicly visible on 2012-05-02
  - accompanying talk MINOS-DocDB-9084 (via https using cert)
    - a copy of which is included in this document
  - yesterday I changed access from “beamrw” to “public”
- Almost no progress since…
- Some proposed revisions
  - expanded on metadata ntuple
    - needs to be regularized w/ Luke’s SAM info efforts
  - improved the example code
  - simplify beam “locations”
  - externalize/centralize reweight function & location handling

Restructuring the unified ntuple

- Break sections into separate sub-classes?
  - grouping might make relations clearer
- This allows encapsulation of elements needed for location reweighting:
  -
    - ntype
    - ptype
    - vx, vy, vz
    - pdpx, pdpy, pdpz
    - necm
    - ppenergy
    - ppdxdz, ppdydz, pppz
    - mupare
    - muparpx, muparpy, muparpz

Location, location, location

- Eliminate “near” vs. “far” (and random) distinction
  - STL vectors: `nupx`, `nupy`, `nupz`, `nuenergy`, `nuwgt`
    - still in beam coordinate system and units
  - now reflected in document (+ .h and .cc files)
    - does it make sense to have more than just energy & weight?
      - possibly for near; repetitive for far
      - old entries had dx/dz and dy/dz (in beam frame)
      - new set is easier to use at cost of 1 more value per location
  - standard indices (but tagged for specifics in metadata)

0: random decay
1: MINOS NearDet
2: MINOS FarDet
3: Minerva
4: NOvA NDOS
5: NOvA NearDet
6: NOvA FarDet
7: LBNE Soudan
8: LBNE AshRiver
9: LBNE Lead Surface
10: LBNE Lead Underground
....

?: ArgoNeut

Standardize handling

- Common functions to do common things
  - function for reading a text file of (x,y,z,name) quartet lines
    - returns the vectors for the metadata (or directly fill dkmeta elements)
  - same vectors used to calculate the array of energies/weights
  - agreed upon function for calculating the weights
    - everyone uses it, fixes go in one place
- Create a CVS repository to hold
  - dk2nu.h + dk2nu.cc = basic tree
  - dkmeta.h + dkmeta.cc = meta-data tree
  - readWeightLocations.C = parsing text file to vectors (dkmeta)
  - calcLocationWeights.C = fill dk2nu non-random location info
  - test programs

Previous Talk (2012-05-03) follows

- Slides redux…

Tale of N (N>2) Cities

- The code has been “forked” a number of times
  - each time w/ a loss of prior CVS history
  - corrections to common code apply to each repository
- Output Ntuple formats are inconsistent
  - trouble from the start: gnumi, g4numi, flugg
    - different names, types, capitalizations
    - variants of each of these make additional changes
  - core elements are the same
  - GENIE was coded to handle the original 3
    - Minerva hacked GENIE to handle their variant
    - near impossible to continue along same road in the future

Codebase

- Ideally, the code would get merged back into a single repository and experiments would use CVS (SVN, whatever) branches to handle alternatives
  - if the objection is the repository location then we could start a new completely expt agnostic one
  - would allow easier common fixes and re-integration
  - BIG job to do it in the ideal manner
    - Robert just goes to his cubical and weeps every time he thinks about this task
- Put this on hold for now...

Output Format

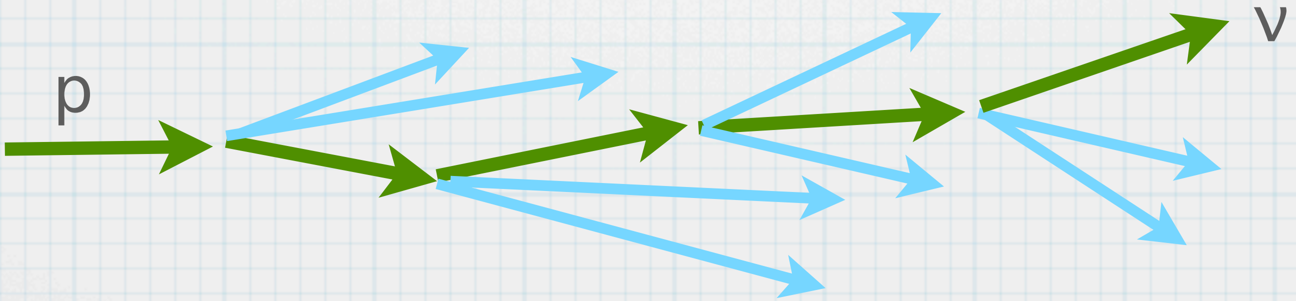
- This is the pressing issue ...
  - GENIE needs this to handle new simulations
  - experiments need some of the new features
  - ...having a single format just makes life easier
- Proposal [MINOS-DocDB-9070]
  - currently still evolving - example code in document!
  - general agreement on principles
  - a tree of "`dk2nu`" class objects
    - represent hadron/muon that decays to a neutrino
    - class is roughly a union of all existing elements
  - a tree of "`dkmeta`" class objects for metadata
    - name choice? tree or just one object in the file?

General Principals

- Naming
  - new name for tree `dk2nu` (`dkmeta`)
  - standardized variable names all lower case
  - no truncation of variable names: `ndxdznear`, not `NdxdzNea`
- Everyone uses a versioned class header
  - additional info can be stored in parallel branches on the tree, but otherwise no unagreed upon changes
  - variables are ints, doubles, strings, vectors
    - no fixed sized arrays
  - class supplies a Clear() method to assign defaults

General Principals

- Biggest addition: ancestor chain
  - concept from Minerva g4numi variant (w/ mods)
  - one entry per state between proton and neutrino
    - [0] = the initial proton; [n-1] = the final neutrino
  - record
    - PDG code
    - starting & final momentum ...
    - starting position
      - don't need final position; stop[j] = start[j+1]
    - other info up for debate



Moving Forward

- Move simulations adiabatically
- gnumi (GEANT3) dead; no new generation?
  - uses hbook/zebra ntuples - hard to convert
  - GENIE will retain ability to read 3 legacy formats
- g4numi & flugg
  - relatively easy to adjust to write new format
    - variable names mostly
  - initially leave new (for that type) variables unfilled
  - metadata filling is the most new code
- flugg: rework code
  - convert text-to-ntuple script to compiled ACLiC code
    - straightforward for the most part
  - priority: add filling ancestor chain
    - necessary hadron production reweighting

Use In GENIE

- `GNuMIFlux` ⇒ `GDk2NuFlux`
  - no longer NuMI specific: LBNE, hopefully Booster too
  - `dk2nu` class constitutes “passthrough” info
    - store this in expt’s data structures “as is” if desired
      - need to explore potential ROOT dictionary clash
        - copy in GENIE & expt framework (each can be used independently)
      - use of STL vector makes this better than fixed arrays because of copy mechanism (no explicit loop written by user)

Timeline

- Hopefully soon!
  - mid-summer?

Beam Simulation

- Common Ntuple format
  - gnumi (geant3, obsolete)
  - flugg (g4+fluka, incomplete)
  - g4numi (+ minerva + lbne variants)
- Shared location for non-expt specific files
- Common mechanism for converting to GSimpleNtpFlux format
  - samples weighted files into form with unweighted rays
  - factorize computation speeds up actual generation
- Merge codebase back to one repository
  - snapshots taken at various times means history was lost, but fixes need to get propagated to multiple repositories
  - experiment based branches from common code allows desired flexibility
- Re-work flugg handling of alternatives
  - use run-time switches, not code recompilation
- Evolve flugg for full ancestor list
  - currently doesn't have all particles between initial proton and particle that decayed to give the neutrino
  - can't apply NA59/NA61 weights
- Physics choices
  - Geant4 PhysicsList alternatives
  - flugg fluka version (2011)
- Incorporation of external knowledge
  - NA49/NA61
  - cross expt hadron re-weighting
    - SKZP works for MINOS but not NOvA
  - revisit muon/hadron monitors?